U. S. FOREST SERVICE
RESEARCH NOTE PSW- 118

CIFIC
1966

SOUTHWEST
FOREST & RANGE EXPERIMENT STATION
P.O. Box 245 Berkeley, California 94701

PACIFIC SOUTHWEST FOREST & RANGE EXPERIMENT STATION
Central Reference File
NOV 73

Brushfield Reclamation . . .

second-year results from a study of reforestation with ponderosa pine are encouraging

PHILIP M. McDONALD

ABSTRACT: Results after two growing seasons from a study in Sierra County, California, indicate: (a) no seedling survival or height differences among site preparation treatments being tested: (b) a significant difference between survival of planted seedlings and those from rangeland drill seeding; (c) a 400- to 600-percent cost advantage with machine planting and rangeland drilling over hand planting and seeding; and (d) no relationship between site preparation or time of spraying and incidence of new or sprouting brush.

After a shaky start, the acreage devoted to timber plantations in California continues to grow. Between 1910 and 1920, about 200 acres were planted annually in California. When results proved disappointing, planting fell into disfavor. Only 250 acres were planted in 1930, but by 1937 the acreage had climbed to 2,000. After a 7-year lapse in the 1940's, the number of acres planted has steadily risen until in 1952 more than 8,000 acres were planted. In 1965, the U.S. Forest Service alone planted 17,474 acres in the State.[1]

Like planting, seeding was tried by early California foresters as far back as 1910. The following year, 2,659 acres were seeded in what has been described as "the banner year in the history of this method."[2] Results were disappointing--seeding seemed to be a gamble. Fowells and Schubert[3] judged it "an ineffective method of regeneration," although they concluded that seed spotting with adequate rodent protection was a satisfactory regeneration method. Of the 4,781 acres of National Forest land artificially seeded in the State from 1910 to 1952, the number of acres classed as complete failure totaled 3,260.

Nevertheless, numerous instances of successful natural seeding do occur--particularly on prepared sites. Foresters are quick to note this success. And because seeding often presents certain advantages of flexibility and economy, it continues to be practiced. In 1965, the Forest Service artificially seeded about 837 acres in California.[1]

But how successful will these plantings be? Foresters need new and better techniques for successful plantations. For as the Forestry Research Advisory Committee has stated: "Highest priority for new or added research should be...reclamation of timber sites that have been invaded by undesirable brush...."[4]

---

[1] U.S. Forest Service. *Annual reforestation and timber stand improvement report, F. Y. 1965.* (Unpublished report on file at Pacific SW. Forest & Range Exp. Sta., U.S. Forest Serv., Redding, Calif.)

[2] Forest Regeneration Committee. *California's forest regeneration problems.* Calif. Div. Forestry. 45 pp., illus. 1955.

[3] Fowells, H.A., and Schubert, G. H. *Recent direct seeding trials in the pine region of California.* U.S. Forest Serv. Calif. Forest & Range Exp. Sta. Res. Note 78, 9 pp. 1951.

[4] Forestry Research Advisory Committee. *Report and recommendations.* 14th Mtg., Flagstaff and Tempe, Arizona. Sept. p. 4. 1965.

The Pacific Southwest Station and the Tahoe National Forest are jointly studying different methods of site preparation and mechanical planting and seeding--methods that would be suitable for rehabilitating brushlands on poorer sites. The test site is the Sugarloaf plantation in Sierra County, California.

The four specific objectives of this study are:

- To correlate differences in brush reinvasion to site preparation methods.
- To test different planting and seeding techniques relative to each site preparation method.
- To determine the cost of different site preparation treatments, as well as the cost of different planting and seeding methods.
- To provide landowners with a better prescription for brushland reclamation.

After two summers of growth, over-all seedling survival at the test site is excellent. No difference among site preparation methods is discernible, but some trends among planting methods are noteworthy.

The Study Site

The Sugarloaf plantation is located in a 750-acre brushfield at an elevation of about 5,500 feet. In this ridgetop area of volcanic flows and gently undulating topography, slopes are less than 15 percent and nearly all aspects are represented. The soils are rather shallow--18 to 36 inches deep--over-lying weathered andesitic parent material;[5] the northeast corner of the plantation is the exception--being basalt. Tentative soil series with corresponding site quality are Cohassett (Site II, low), Lytton[6] (Site III), and Undeveloped Lytton (Site IV to noncommercial). All three soils characteristically are stony, with occasional surface rock outcrops.

Annual precipitation averages about 80 inches. Most of this falls as winter snow, although summer thunderstorms often occur.

The present brushfield originated in 1924, the last time the area burned. Before this study was begun, the vegetation consisted of a dense, tall, vigorous stand of timberland chaparral--mostly of sprouting species. Predominant was greenleaf manzanita (*Arctostaphylos patula* Greene), which averaged about 6 feet tall. Less abundant but generally distributed were mountain whitethorn (*Ceanothus cordulatus* Kell.), bush chinkapin (*Castanopsis sempervirens* [Kell.] Dudl.), bitter cherry (*Prunus emarginata* [Dougl.] Walp.), and huckleberry oak (*Quercus vaccinifolia* Kell.). A few scattered conifers--chiefly white fir (*Abies concolor* [Gord. & Glend.] Lindl.) and ponderosa pine (*Pinus ponderosa* Laws.)--were encroaching into the brushfield.

Six site-preparation treatments with two replications were randomly applied to 12 5-acre rectangular blocks. They were as follows:

1. Bulldoze in spring, spray in following spring, plant 24 months after initial work.
2. Same as above, except use a brush rake.
3. Bulldoze in fall, spray in following fall, plant 18 months after initial work.
4. Same as No. 3, except use a brush rake.

[5] Bradshaw, K. E. *Vegetation investigation of Sugarloaf site preparation plots, Downieville Ranger District, Tahoe National Forest.* 1962. (Unpublished report on file at Pacific SW. Forest & Range Exp. Sta., U.S. Forest Serv., Berkeley, Calif.)

[6] Similar to the Windy soil series in Shasta County, California.

5. Bulldoze in fall, no spraying; plant 6 months after initial work.

6. Same as No. 5, except use a brush rake.

Three methods of planting and two of seeding were then installed in each block: machine plant, hand plant with planting tool, hand plant with soil auger, rangeland drill, and hand seed (seed spot).

Half of each block was mechanically planted and half was mechanically seeded with the hand planting and seeding trials, respectively, in the centers of each half (fig. 1).

Before seeding, ponderosa pine seeds were stratified for 60 days at 38°F. and treated with endrin-arasan. After stratification, 95 percent of the seeds germinated in 7 days. The metering rate on the rangeland drill was set to drop 1 to 2 seeds per lineal foot from two drills spaced 8 feet apart. The planting stock was zone III ponderosa pine (1-0 stock) from the U.S. Forest Service Nursery at Placerville, Calif. Spacing was 8 x 8 feet in symmetrical rows.

The herbicide consisted of 2,4-D and 2,4,5-T applied with a power sprayer. The per-acre rate was 3 pounds of each acid in 10 gallons of stove oil emulsion (80 percent water).

The usual procedure in clearing brushfields is to blade the uppermost 4 to 6 inches of soil into the windrows so that most brush seeds are also removed. At Sugarloaf, the soils are too shallow for this practice; any loss of valuable topsoil would be prohibitive. Hence, the bulldozer operator was directed to minimize the loss of topsoil, but still remove the brush root crowns. About 2 inches of soil were "moved" in the bulldozing. As expected, the brush rake removed very little soil.

Sampling and Analysis

The sampling unit (survival plot) was keyed to a randomly located line which intersected six rows of planted or seeded stock. In the seeded half of the block, the line intersected two rows of seed spots, and four rows seeded with the rangeland drill. This larger sample for the drill was necessary because more variation in seedling survival was anticipated from it. In the planted portion, the line intersected two rows of stock hand planted with a planting tool, and two rows hand planted by a soil auger; a machine planted row lay on each side. The .03-acre survival plot was replicated twice in each half of each block.

Two of the four plots in each block were randomly selected for sampling brush coverage and abundance by a cluster of four milacre quadrats. The cluster center was the same as the center of the selected survival plot. A 1-foot square wire frame aided the estimation of brush coverage.

Analysis was by group comparisons,[7] comparisons of binomial data,[8] and two randomized block analyses of variance.

Results

Clearing the brushfield began in the spring of 1962 and ended in the fall of 1963. Poison grain treated with sodium fluoro-acetate (1080) was applied in May 1964, but its effectiveness was not measured. Both planting and seeding were completed by the first of June 1964. The weather was ideal--raining before, during, and after both operations.

---

[7] Snedecor, George W. *Statistical methods.* 534 pp., illus. Ames: The Iowa State College Press. 1957.

[8] Husch, Bertram. *Forest mensuration and statistics.* 474 pp., illus. New York: Ronald Press. 1963.

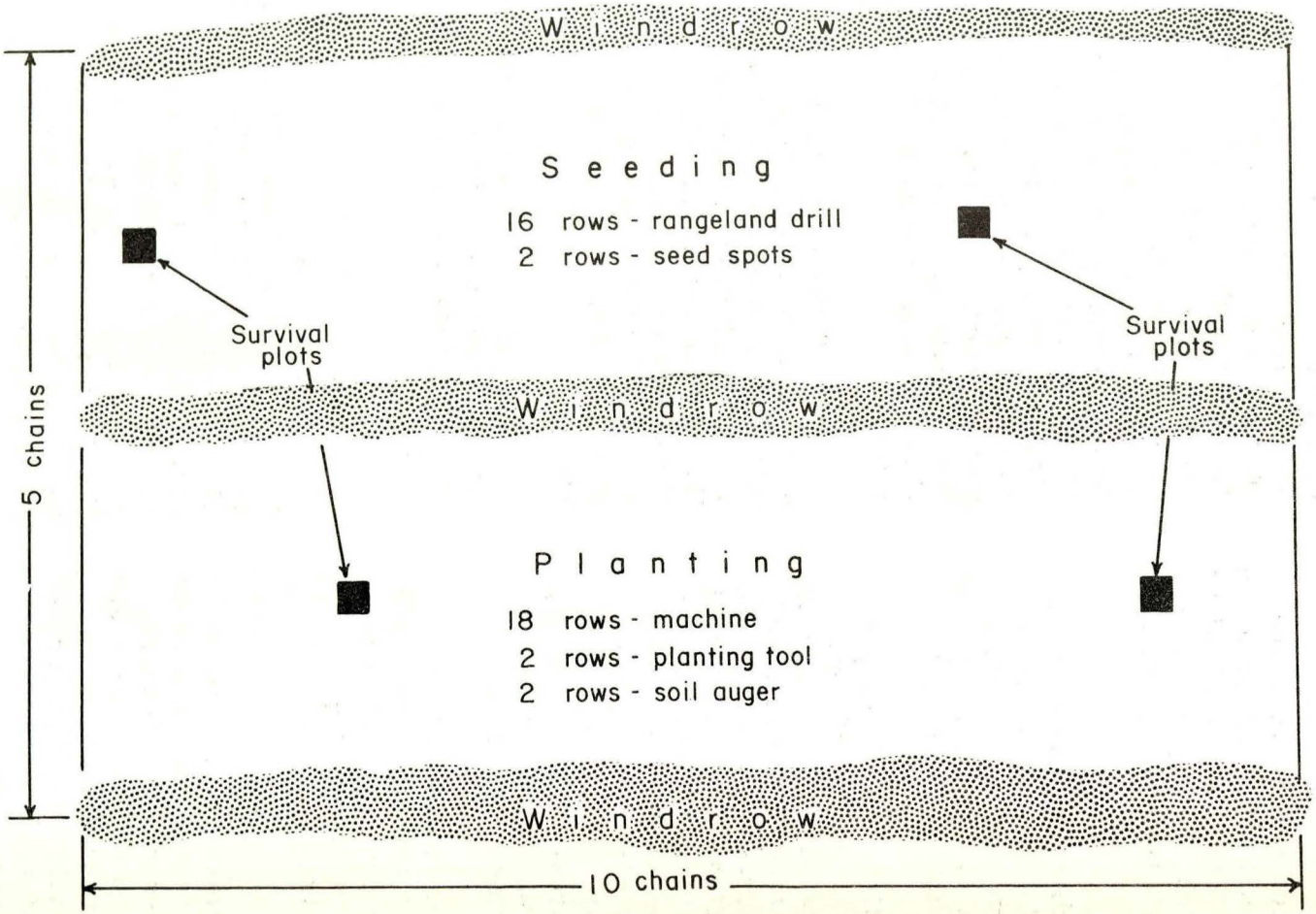
W i n d r o w
S e e d i n g
16 rows - rangeland drill
2 rows - seed spots
Survival plots
Survival plots
W i n d r o w
P l a n t i n g
18 rows - machine
2 rows - planting tool
2 rows - soil auger
W i n d r o w
5 chains
10 chains

Figure 1.--Typical site preparation block showing the different methods of planting and seeding as well as the relative location of the survival plots.

Seedling survival was evaluated 1 month after seeding and planting. No difference was apparent between the rangeland drill and the hand seeded "spots." Survival by planting method was as follows, in July 1964:

Soil auger.	100 percent
Planting tool	99 percent
Machine	97 percent

A more detailed examination of seedling survival and height was completed in mid-September 1965. The summer had been unusually wet, and the soil was moist below the surface inch at the time of sampling.

Planted seedlings.--Survival of the planted seedlings continued to be rated excellent. Survival by planting method was as follows:

Soil auger.	92 percent
Planting tool	91 percent
Machine	89 percent

No statistically significant differences could be found among site preparation treatments or among the three different methods of planting. And mortality by planting method remained a constant 8 percent. Thus the ranking of the treatments was unchanged from that in the previous survey. Heights of the seedlings ranged from 0.4 to 1.3 feet, and were remarkably similar for all plantings (fig. 2).

Seedlings from seed.--To evaluate the effectiveness of the rangeland drill, some arbitrary form of "plot" is necessary. Hence, 8-foot segments of drill row formed the basis for evaluating seedling survival. Only 63 percent of the drill row segments had one or more seedlings, compared to 88 percent for the seed spots--a statistically significant difference. Where seedlings were present, there were usually several of them, averaging 9.2 seedlings per seed spot and 4.3 seedlings per 8-foot segment of drill row. Seedling heights averaged 0.27 feet for the seed spots (fig. 3) and 0.23 feet for drilled seeding (fig. 4).

Brush.--Many dead plants were apparent in blocks where site preparation included spraying. The number of resprouting brush crowns is now relatively few, but where present sprouts are already actively competing with planted stock. The most serious threat, however, is the many 1- and 2-year-old brush seedlings, primarily manzanita, which germinated after the clearing and spraying (table 1). These may soon be actively competing with the young pine.

The bulldoze-no spray treatment was associated with the highest brush coverage and probably the highest incidence of sprouting brush. The rake-no spray treatment, which logically should also have a high brush coverage, did not. No trend is apparent between the incidence of brush and the method of site preparation or time of spray.

Cost.--Detailed costs were recorded for each operation. In addition to labor, machinery, chemical, and planting stock and seeds, other recorded costs were equipment rental, administration, transportation, and repair.

Of the various planting and seeding methods, the rangeland drill was the cheapest, followed in order by machine planting, hand seeding, and hand planting. Although the costs of machine planting, and seeding with the rangeland drill were almost similar, the costs of hand seeding and hand planting were four and six times more expensive, respectively. Planting and seeding cost about one-third that of site preparation.

Discussion and Conclusions

Except where the rangeland drill was used, survival was equally good among the different methods of planting (table 2). But planted seedlings were more than twice as tall as those which began as seed. Of future interest will be the seed spots--will a single seedling assume dominance and outstrip its contemporaries? Or will

Figure 2.--This machine-planted ponderosa pine seedling is more than 1 foot tall after two summers of growth. Stony soil often is encountered in the Sugarloaf plantation.

Figure 3.--A well stocked seed spot. In spite of their crowding, the seedlings are vigorous and of good color.

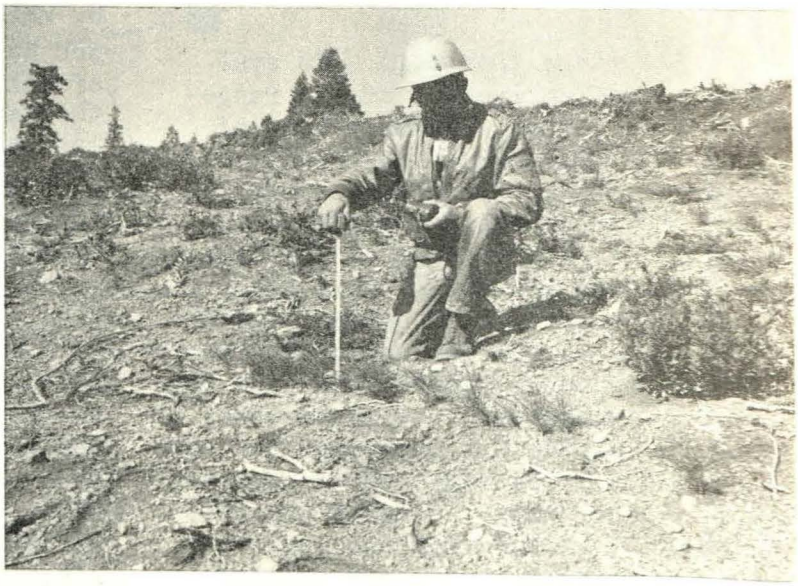

Figure 4.--A well stocked section of row seeded by the rangeland drill. Dead brush stocks and resprouting brush appear in the background.

Table 1.--*Relationship of brush to site preparation 2 years after treatment, Sugarloaf plantation, 1965*

Treatment	Brush seedlings per milacre quadrat[1]	Crown coverage
	Number	*Percent*
1. Rake - spring '62 Spray - spring '63	25	3.8
2. Bulldoze - spring '62 Spray - spring '63	16	2.4
3. Rake - fall '62 Spray - fall '63	52	3.1
4. Bulldoze - fall '62 Spray - fall '63	34	5.6
5. Rake - fall '63 No spray	18	2.6
6. Bulldoze - fall '63 No spray	14	9.0

[1]Average of 16 quadrats.

Table 2.--*Second-year seedling survival and height, by planting method, Sugarloaf plantation, 1965*

Method	Survival	Avg. seedling height
	Percent	*Feet*
Planting:		
Soil auger	92	0.59
Planting tool	91	.54
Machine	89	.57
Seeding:		
Seed spotting	88	.27
Rangeland drill	63	.23

all the seedlings in each spot remain at a constant height, stagnate, and die? In some of the seed spots, a seedling or two are already indicating dominance, but it is too early to tell whether this will occur in every seed spot.

Strictly from a cost view point, the landowner interested in stocking an area may find it most advantageous to use the rangeland drill--if he is willing to accept small seedlings, a somewhat uneven or clumpy seedling arrangement, and a 63-percent survival at the end of the second summer.

But use of the rangeland drill might be too risky for conditions similar to those at Sugarloaf. Several rows of dead seedlings, and others without a trace of a seedling, were obvious in this planting method. Where present, the seedlings were noticeably less vigorous as judged by color, needle length, and length of apical bud. These factors suggest that future mortality will probably be greatest here.

Machine planting has the advantage of being both cheap and effective. In addition to high survival and good

height growth, the planted seedlings are vigorous and healthy. And they appear able to compete with the oncoming brush. The soil auger, although more costly, will continue to be a valuable tool on those "special" areas that are too steep or rocky for machine planting.

The Author

PHILIP M. McDONALD is studying silvicultural problems of young-growth Sierra forests, with headquarters at Redding, Calif. A native of Seattle, Washington, he holds bachelor's (Washington State University, 1960) and master's (Duke University, 1961) degrees in forestry.